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Geophysical examples

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Lock-exchange

- Flat bottomed tank, separated into two portions by a barrier.
- Portions are filled with fluids of different temperature (density).
- As the barrier is removed, the denser fluid collapses under the lighter.

Figure: Lock-exchange initial temperature (color) distribution.

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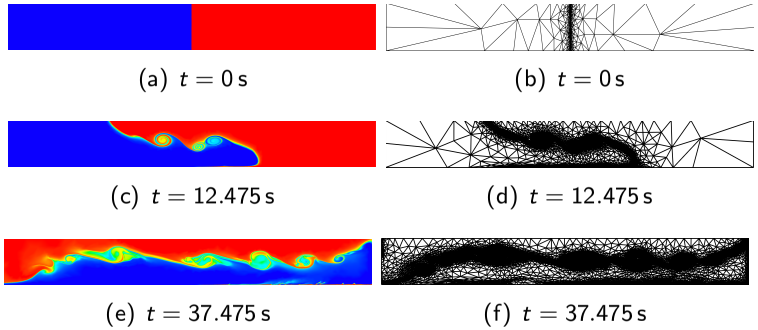
Solution



(a) $t = 0\,\mathrm{s}$ (b) $t = 0\,\mathrm{s}$

(c) $t = 12.475\,\mathrm{s}$ (d) $t = 12.475\,\mathrm{s}$

(e) $t = 37.475\,\mathrm{s}$ (f) $t = 37.475\,\mathrm{s}$

Figure: Lock-exchange temperature distribution (colour) with meshes, over time (t)

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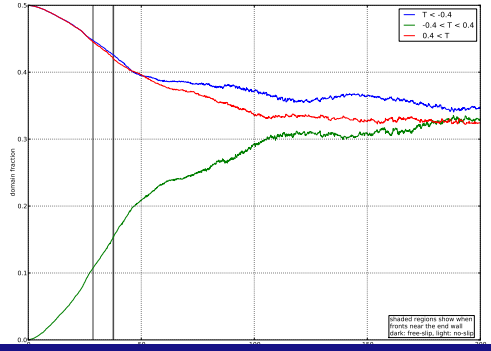
Diagnostics

- Front speed (or Froude number): The bottom and top front give the no-slip and free-slip Froude number, respectively.
- Domain fraction.



temperature classes.

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Exercises

- Play with the adaptivity options.
- Try adding some detectors to visualise the particle trajectories.

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Rotating periodic channel

- Domain: Unit square, periodic in zonal direction and zero-slip on North and South boundaries and Coriolis forcing.
- The flow is driven by a velocity source term:

$$\mathbf{F} = \begin{bmatrix} y^3 \\ 0 \end{bmatrix}$$

- Parameters are chosen such that the solution converges to a steady state with known analytical solution.

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Solution

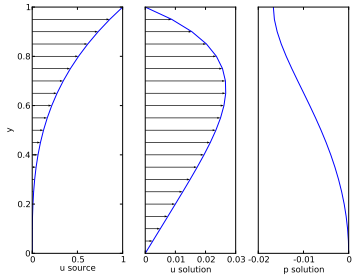

Figure: Velocity forcing term and analytic solutions for velocity and pressure for the rotating periodic channel test case. Note that each of these quantities is constant in the x direction.

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Convergence

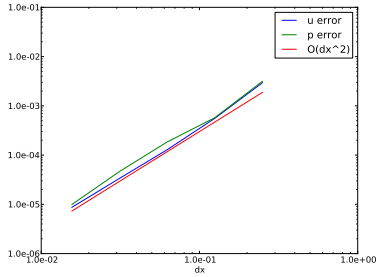

Figure: Error in the pressure and velocity solutions for the rotating channel as a function of resolution.

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Exercises

Understand the use of analytic forcing functions in Fluidity using Python.

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The restratification following open ocean deep convection

Idealised model of the restratification phase of OODC

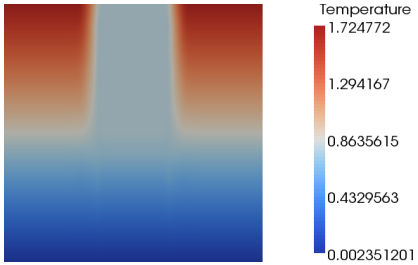

Figure: A vertical slice throught the domain showing the initial temperature stratification. The domain is a cylinder of radius 250 km and height 1 km.

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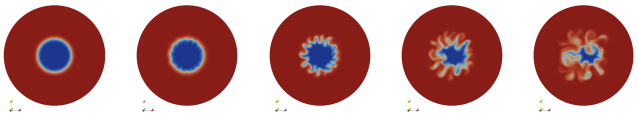
Solution



(a) 0 days (b) 10 days (c) 20 days (d) 30 days (e) 40 days

Figure: The temperature cross-section at a depth of 40m.

... show video

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Exercises

- Work out the kinetic and potential energies using the vtus or stat file
- Try running with different resolutions and look at the effect on the eddies

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Tides in the Mediterranean Sea

- Tidal modelling is a widely used method for validating free surface implementations.
- Flow is driven by both astronomical and co-oscillating boundary tide forcing for the four main tidal constituents: M_2 , S_2 , K_1 and O_1.

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Solution

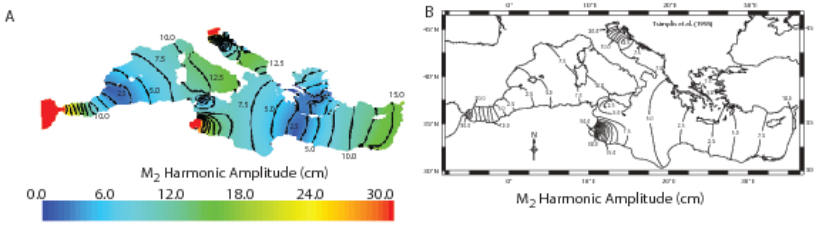

Figure: Plots of the M_2 tidal harmonic amplitude in the Mediterranean Sea from ICOM and the high resolution model 2D model.

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Diagnostics

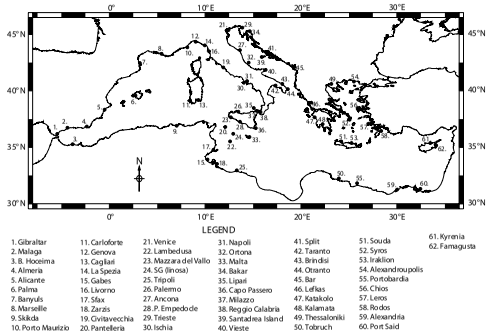

Figure: The locations of 62 tide gauges in the Mediterranean Sea to calculate the root mean square error.